THE EXCRETION OF SPIROCHAETA PALLIDA THROUGH THE KIDNEYS

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That spirocheturia is a striking phenomenon in Weil's disease was first demonstrated by Inado and Ito,[1] who, in February, 1915, announced the discovery of Spirochaeta icterohaemorrhagica as the cause of this infection. The excretion of the spirochetes in the urine was shown by successful transmission of the disease through inoculations of urine from infected animals and patients. Dark-field examinations of the urine in the early stages of infectious jaundice reveal the presence of the spirochetes in small numbers; from the tenth to the twenty-fifth days they are usually found in enormous numbers. After this time they degenerate and finally disappear by the fortieth day. Their appearance in the urine in numbers is usually coincident with the beginning formation of immune bodies. Pathologic studies showed that the spirochetes are present in the kidneys in great numbers, even more so than in the liver. They are massed in the intertubular interstitial tissues especially, but are found also in the wall and lumen of the tubules. The kidneys present the appearance of acute degenerative nephritis. In November of the same year Uhlenhuth and Fromme,[2] independently working on Weil's disease in Germany, reported also the discovery of the presence of a spirochete in the blood, liver, kidneys and urine of human cases and inoculated guinea-pigs which they regarded as the cause of infectious jaundice. The occurrence of icterogenic spirochetosis was recognized in the British and French armies during 1916-17; and the importance of spirocheturia as an early diagnostic factor was insisted on by a number of writers, particularly in France. Recognition of the spirocheturia was one of the chief points leading to the establishment of the identity of "trench" or "war jaundice" with Weil's disease. The value of this sign became questioned by a number of observers because

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[1] Jour. Exper. Med., 1916, 23, p. 377.

[2] Med. Klin., 1915, 11, pp. 1202 and 1264; Ztschr. f. Immunitätsf., 1916, 25, p. 317.

of the possible contamination of urine with the spirochetes present in the meatus or on the glans. Other workers showed that with proper precautions such urethral contaminations could be avoided; and the demonstration of a renal spirocheturia remains one of the most important phenomena of Weil's disease of diagnostic value.

In 1917, Garnier and Reilly[3] studied especially the renal lesions of infectious jaundice and their relation to the excretion of the spirochetes. They found that the elimination of the spirochetes takes place chiefly through the convoluted tubules. The degenerative lesions are confined to the epithelium of these tubules, while the glomeruli remain unaffected. Accompanying the epithelial degeneration there is an interstitial reaction which in cases running a long course may approach sclerosis. In cases in which death occurs early there is an arrest of the renal function with or without cytolysis of the tubular epithelium. In patients dying later the lesions are more marked and extensive, with homogenization of the cytoplasm. Fatty degeneration does not occur. The spirochetes at first are massed in the intertubular spaces, and later pass through the epithelium toward the lumen of the tubule. At the inner pole of the cells they begin to show fragmentation and attenuation, finally breaking up in part into granules, while others pass apparently unchanged into the lumen of the tubule and out with the urine. Throughout the tubules desquamated epithelial cells and casts containing spirochetes also occur.

Other observers have confirmed the importance of the renal lesions and the spirocheturia occurring in infectious jaundice during the septicemic stage of the disease. Spirochetes regarded as identical with the parasite of infectious jaundice have been found in the kidneys and urine of wild rats in Japan, Belgium, France and America. We possess, however, little knowledge concerning the excretion of other forms of spirochetes through the kidneys. Futaki found spirochetes in the kidney in typhus fever, but his observations have not been confirmed. This stimulated a group of Japanese workers to an intensive research on the occurrence of spirochetes in the kidneys. Kou, Watabiki and their associates[4] found by the Levaditi method what they took to be spirochetes in 26 of 50 kidneys from cadavers and in 15 of 26 kidneys removed surgically. The spirochete-like bodies were found only in casts or detritus in the lumen of the tubules, and were not present in the interstitial tissue, epithelial cells or blood vessels with the exception of an occasional occurrence in the glomeruli. There was no reason to believe that they were associated with any definite disease or that they were being eliminated by the kidneys. It was thought that they might represent an ascending saprophytic infection from the smegma. Three types were described, always mixed together. They were not all sharply differentiated from Spirochaeta pallida, but were considered different morphologically. Other evidence of syphilis was not present in these cases. There can be little doubt that the bodies found were not true spirochetes, but represent the same silver-impregnation forms somewhat resembling them seen by a number of European observers in the tubules of kidneys showing lesions of acute nephritis.

Ido, Ito and Waji[5] state that in seven-day fever a condition of spirocheturia closely resembling that of infectious jaundice is found. The spirochetes (Sp.

[3] Compt. rend. Soc. de biol., 1917, 80, p. 38; Arch. de méd. et d'Anat. path., 1918, 28, p. 375; Presse méd., 1918, 26, p. 505.

[4] Tokyo Med. News, 1917, p. 2375.

[5] Tokyo Med. News, 1917, No. 2053.

hebdomadis) appear in the urine after the eighth day, the organisms occasionally occurring in great numbers. From the eighteenth to the twenty-fifth day they are found constantly, and may persist to the thirty-ninth day. The disease resembles very much an atypical Weil's disease. According to Kusama, Koboyashi and Kuzunshi,[6] the spirochete of rat-bite fever (Sp. morsusmuris) is rarely excreted in the urine of infected guinea-pigs. The spirochetes of relapsing fever (Sp. recurrentis) have been demonstrated in sections of the kidney taken from patients and infected animals, but no study seems to have been made of the occurrence of spirocheturia in this infection. It is of great

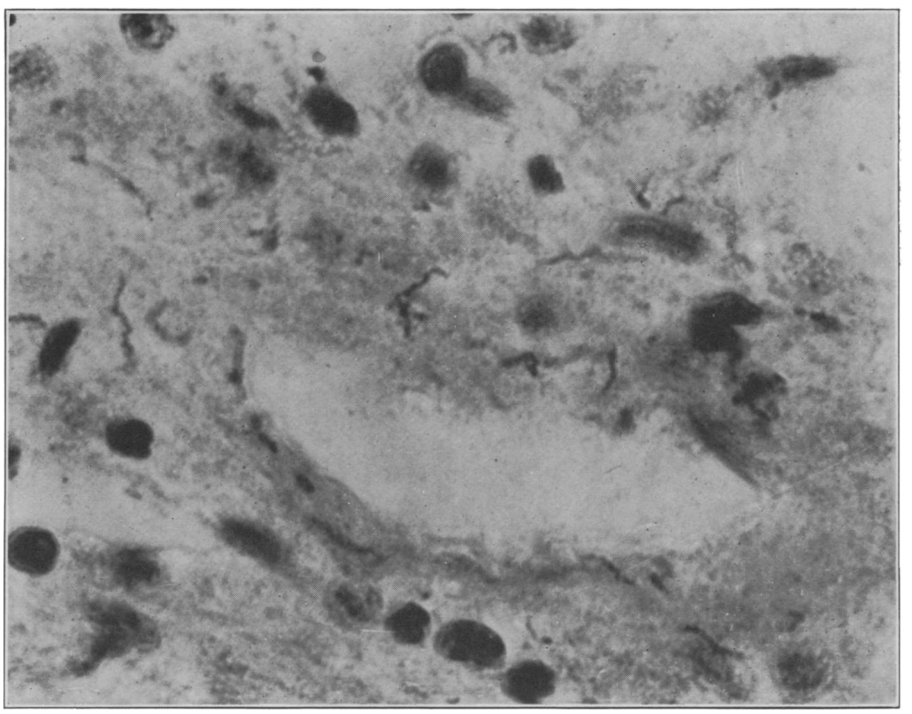

Fig. 1.—Low power view of small kidney arteriole showing numerous Spirochaetae pallidae in wall of vessel and perivascular interstitial tissue. Warthin-Starry silver-agar method. Photomicrograph, Zeiss objective F, compensating ocular, No. 4, bellows length 85 cm.

Note on illustrations. All material used in the photomicrographs was fixed in formol, imbedded in paraffin, sections mounted on coverglasses and stained according to the Warthin-Starry silver-agar method with the additional treatment with hydrogen peroxide to clear the background.

interest that the first observation of the occurrence of spirochetes in yellow fever was that made by Stimson,[7] in 1907. In Levaditi preparations of kidney from a case of yellow fever occurring during the epidemic in New Orleans in 1905, Stimson found a spirochete in the renal tubules, both in the epithelial cells

[6] Saikingaku Zasshi, 1918, p. 1.

[7] U. S. Public Health Reports, 1907, 22, p. 541.

and in the lumen (Sp. interrogans). According to Noguchi,[8] the morphologic characteristics of this organism appear to be identical with those of Leptospira icteroides, which he regards as the possible cause of yellow fever, and which he finds in the kidneys of guinea-pigs inoculated with this organism. No study of the excretion of this organism through the kidneys has yet been made.

In the case of Spirochaeta pallida few observations exist of the demonstration of this organism in the urine. In 1912, Vorpahl[9] reported the case of a woman, 38 years of age, who had had, 12 years before, an ulcer on the genitalia, and had taken a "Schmierkur" with apparent success. There was no history of

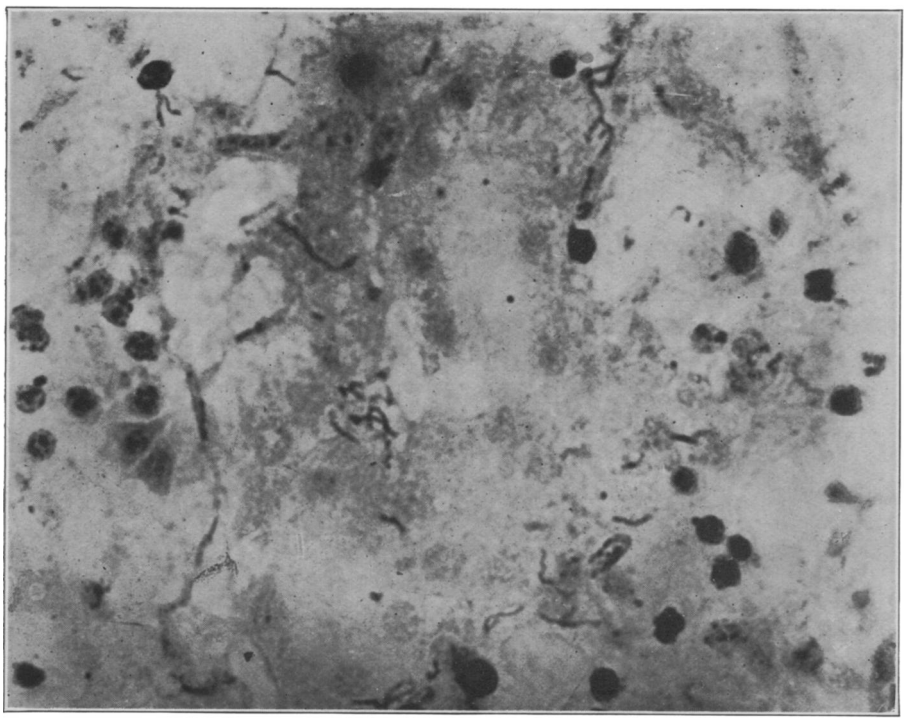

Fig. 2.—Low power view of convoluted tubule showing arrangement of Spirochaeta pallida in wall of tubule and in renal epithelium. Warthin-Starry silver-agar method. Photomicrograph, Zeiss objective F, compensating ocular, No. 4, bellows length 85 cm.

a new infection. For 3½ months she had had symptoms of nephritis. The Wassermann reaction was strongly positive, and gummatous ulcers were found in the throat. In the urine obtained by catheterization, centrifugated and examined by the India-ink method, 3 spirochetes, said to be morphologically like pallida, were found. Antisyphilitic treatment gave good results as far as the symptoms of nephritis were concerned. In the same year, Hoffmann[10] reported two cases of

[8] Am. Jour. Hyg., 1921, 1, p. 118.
[9] München. med. Wchnschr., 1912, 59, p. 2811.
[10] Deut. med. Wchnschr., 1913, 39, p. 353.

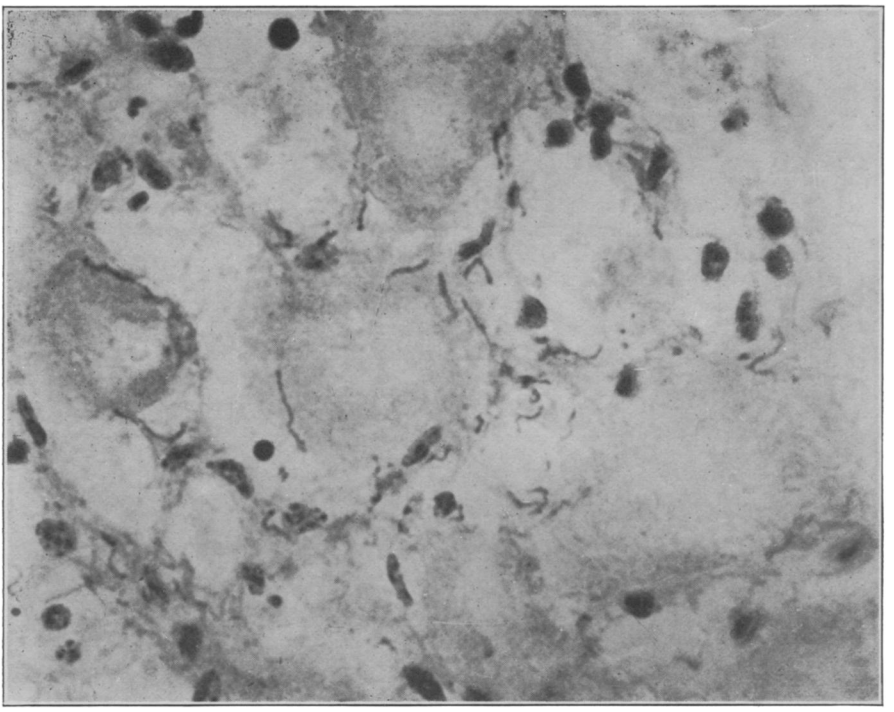

Fig. 3.—Low power view of renal tubules showing great numbers of spirochetes in walls of various portions of convoluted tubules. Warthin-Starry silver-agar method. Photomicrograph, Zeiss objective F, compensating ocular, No. 4, bellows length 85 cm.

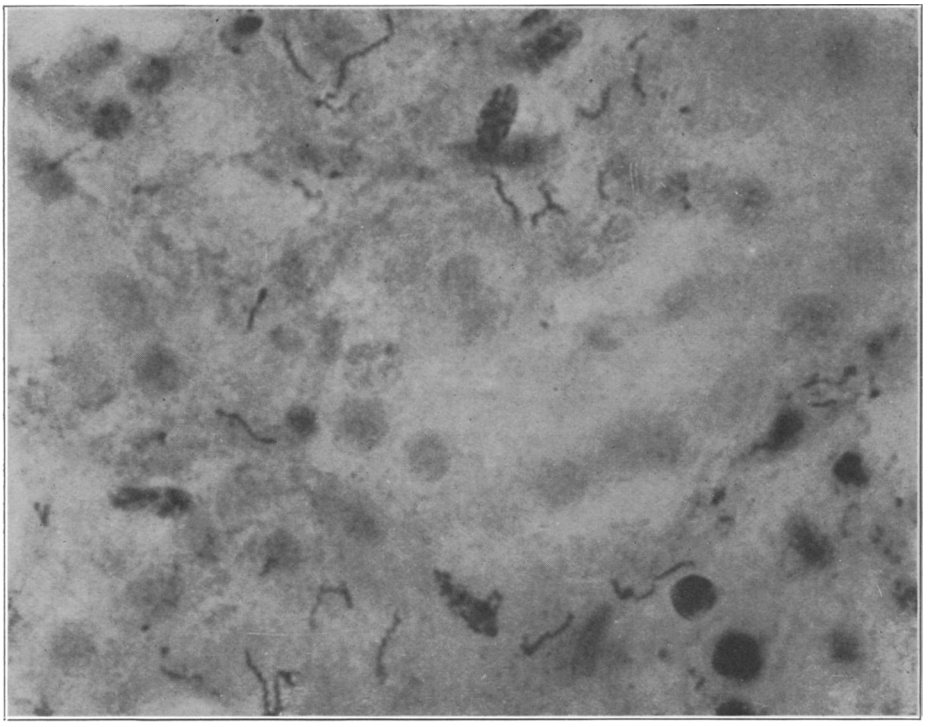

Fig. 4.—Slightly higher power view showing massing of Spirochaeta pallida between and in the walls of tubules. Warthin-Starry silver-agar method. Photomicrograph, Zeiss objective F, compensating ocular, No. 4, bellows length 85 cm.

early acute syphilitic nephritis. In one of these the patient showed a roseolar eruption with nephritic edema, massive albuminuria and granular casts. The urine obtained under precautions to avoid contamination showed numerous living Spirochaetae pallidae in dark-field examinations.

In 1919, Lévy and Guilé [11] conducted researches to ascertain the presence of Spirochaeta pallida in the urine of syphilitic patients. They concluded that the demonstration of syphilitic spirochetes in the urine of patients with untreated syphilis is difficult and rarely successful. They found 2 spirochetes of the

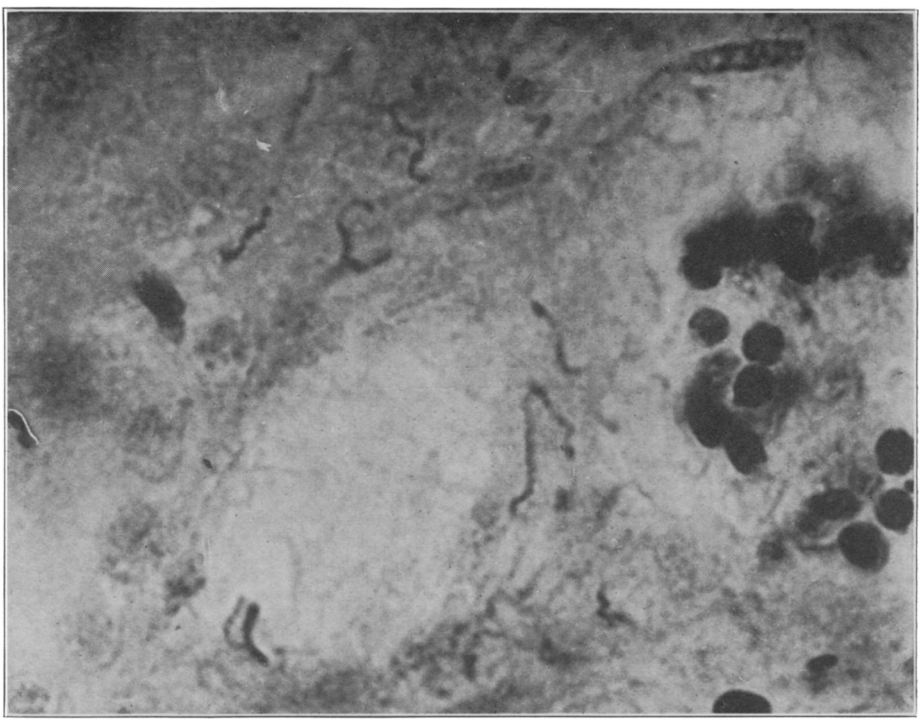

Fig. 5.—Medium power view of Spirochaeta pallida in wall of tubule and in interstitiitial tissue near a glomerulus, a portion of which is seen at the right. Warthin-Starry silver-agar method. Photomicrograph, Zeiss objective 5, compensating ocular, No. 4, bellows length 150 cm.

syphilitic type in one case at the beginning of the roseolar stage. They were not certain whether they were of renal or of local origin. They believe that the most favorable time for the demonstration of syphilitic spirocheturia is at the end of the first month after the appearance of the chancre, at the appearance of the roseola. Such an elimination of spirochetes, they believe, would be of fleeting duration, but its demonstration at this time, when the diagnosis is often in doubt, might be of great value in fixing with certainty a diagnosis of syphilis.

[11] Compt. rend. Soc. de biol., 1918, 82, p. 65. Bull. et mem. Soc. méd. d'hôp. d. Paris, 1919, 43, p. 48.

The same writers also studied the action of urine on Spirochaeta pallida. They found some organisms still recognizable after 17 hours' standing in urine; others showed elongated, straightened or effaced spirals, while great numbers showed contraction and degeneration. In 1921, Fiessinger and Huber [12] found Spirochaeta pallida in the urine of a young man with a roseolar syphilid, about one month after the development of the primary lesion. In 12 other cases of secondary syphilis seen during 3 years, and given especial examination with reference to the occurrence of spirocheturia, no spirochetes could be found in the urine.

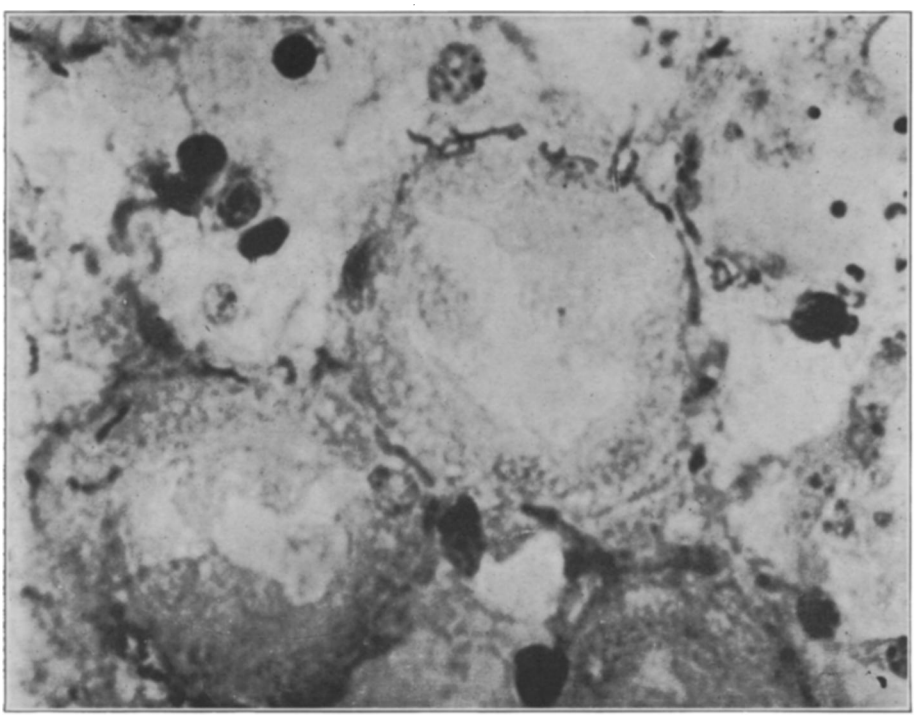

Fig. 6.—Medium power view of constricted portion of convoluted tubules showing massing of spirochetes in basement membrane. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 5.

On the other hand, Le Play, Sèzary and Pasteur Vallery-Radot [13] insist that in certain nonsyphilitic forms of nephritis there may be found in sections of the kidney impregnated with silver according to the methods of Bertarelli and Volpino certain spiral structures which are not true spirochetes although they resemble spirochetes and might, therefore, be mistaken for them. It is probable that the spirochete-

[12] Bull. et mém. Soc. méd. d'hôp. de Paris, 1921, 45, p. 146.
[13] Comp. rend. Soc. Biol., 1912, 73, p. 635.

like forms seen in Levaditi preparations of kidney by the Japanese workers mentioned may be identical with these. Such gross errors of identification of spirochetes in silver-impregnated tissues are due entirely to inexperience in spirochete morphology, and should not occur today. With the improved methods of silver staining applied to single sections, spirochete-like artefarcts are never produced.

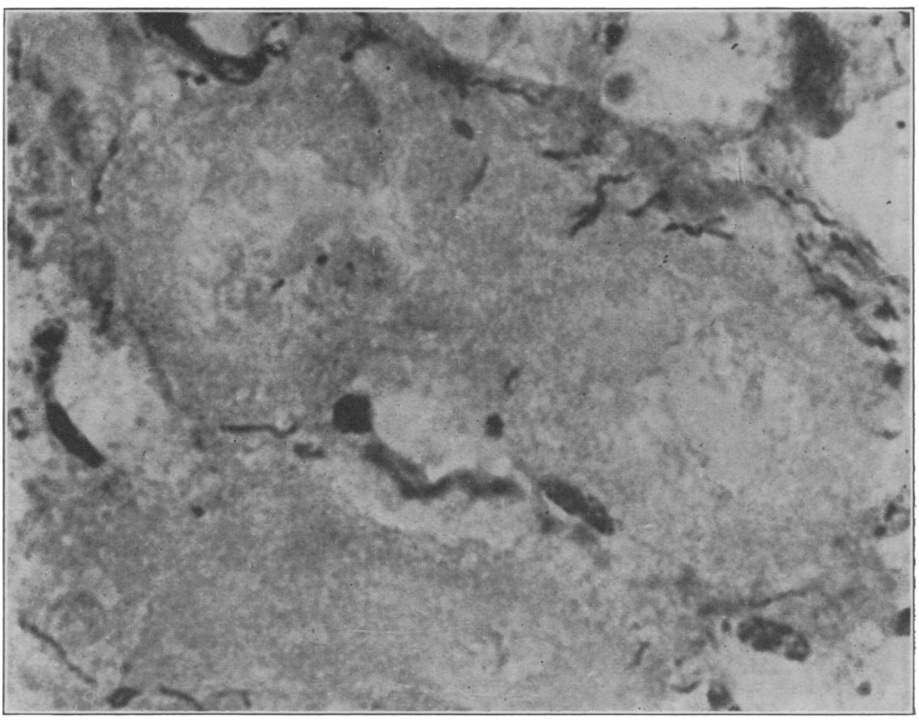

Fig. 7.—Medium power view of convoluted tubule showing spirochetes in basement membrane and epithelium of the tubules. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 5.

Excluding all palpable errors of this kind with reference to the demonstration of spirochetes in the urine and in the renal tubules, the observations cited are the only ones in which the excretion of Spirochaeta pallida in the urine has been demonstrated. It is true that in some of the studies on the distribution of the spirochetes in the organs and tissues of congenital syphilis Spirochaeta pallida has been seen in sections of kidney tissue in great numbers without apparent coincident

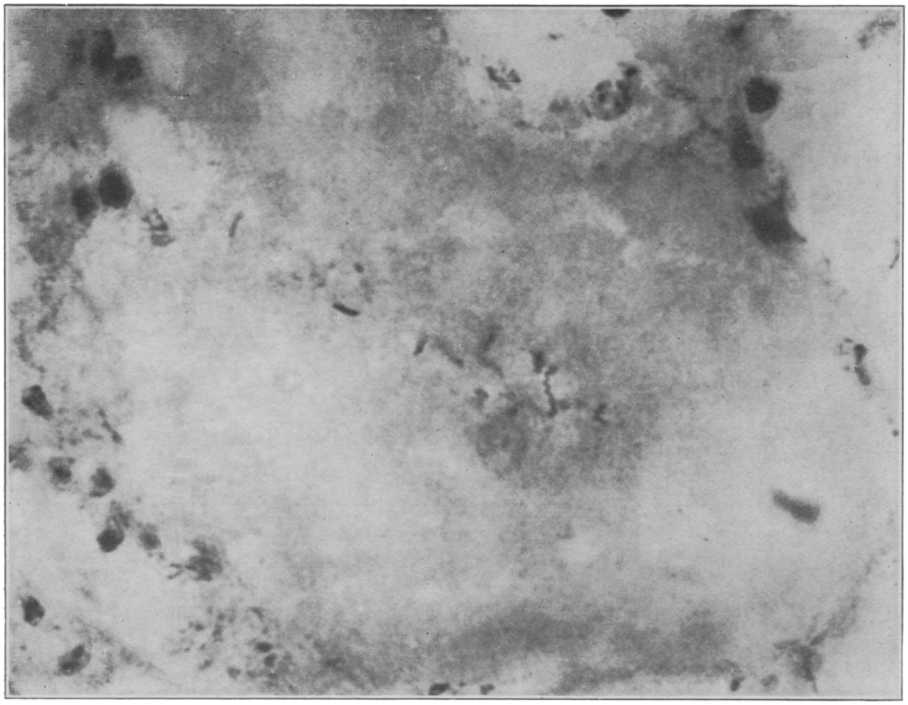

Fig. 8.—Medium power view of convoluted tubule showing degenerating spirochetes in renal epithelium. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 5.

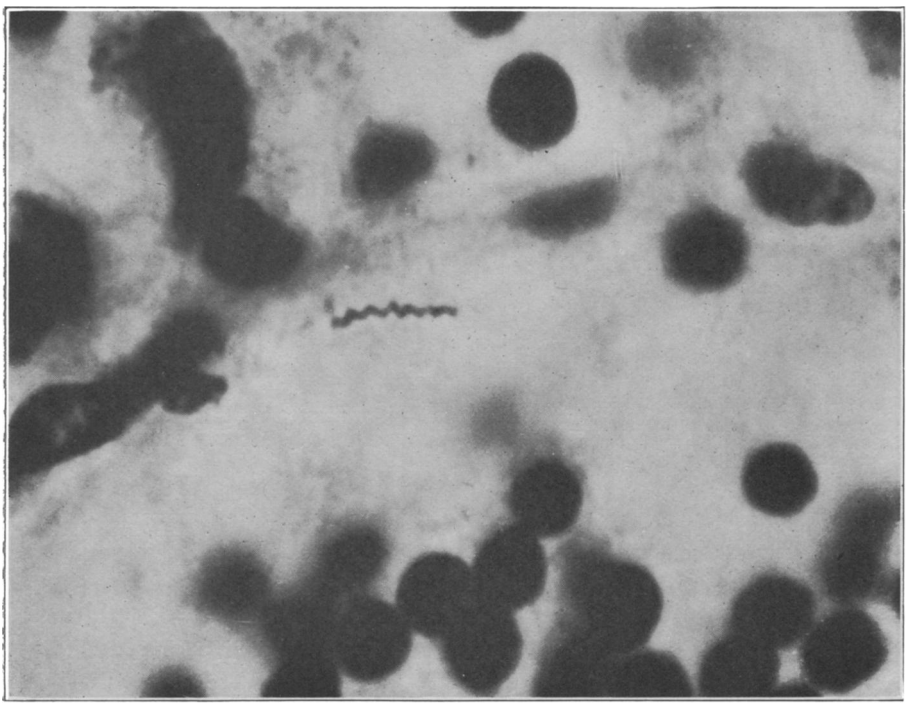

Fig. 9.—High power view of single Spirochaeta pallida in subcapsular glomerular space. Warthin-Starry method. Photomicrograph, B. L. oil-immersion, 2 mm.; compensating ocular No. 4, bellows length 85 cm.

tissue lesions, but no note has been made of the excretion of the organism through the renal tubules. In my own experience, in the study of spirochete distribution throughout the tissues in congenital syphilis, I have found the organisms in varying numbers in the kidneys in all cases in which there was a marked spirochetosis of other organs. With the exception of the three cases to be mentioned, this renal localization seemed to be unassociated with any lesion of the renal epithelium, and no especial attention was paid to the demonstration of an excretion of

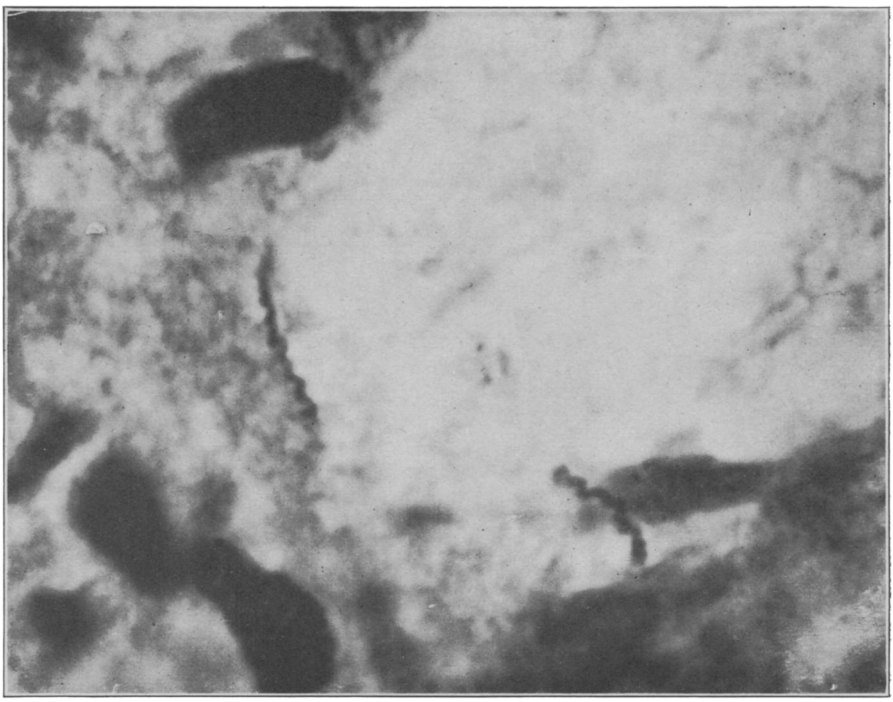

Fig. 10.—Spirochaeta pallida in endothelium of small intertubular vessel. The straightened appearance of one of the spirochetes on the endothelial surface is characteristic. The lower spirochete is passing through an endothelial cell. Warthin-Starry method. Photomicrograph; same magnification as fig. 9.

the spirochetes by way of the urine, although this was regarded as a possibility and has often been mentioned in my teaching.

In 3 cases of congenital syphilis studied, one of a child dying at birth, another dying 8 days after birth, and the third at 3½ years of age, the kidneys presented an unusual degree of spirochete localiza-

tion with definite lesions. In 2 cases of acquired syphilis, those of a young man with a roseolar eruption and a young woman with maculopapular eruption, both dying from arsphenamin poisoning, a similar localization of spirochetes in the kidneys with positive evidences of excretion through the renal epithelium into the tubules was observed. The material from these 5 cases constitutes the basis of this study. Identical conditions and changes were present in all 5 of these cases. No arsphenamin treatment had been administered to the patient with the

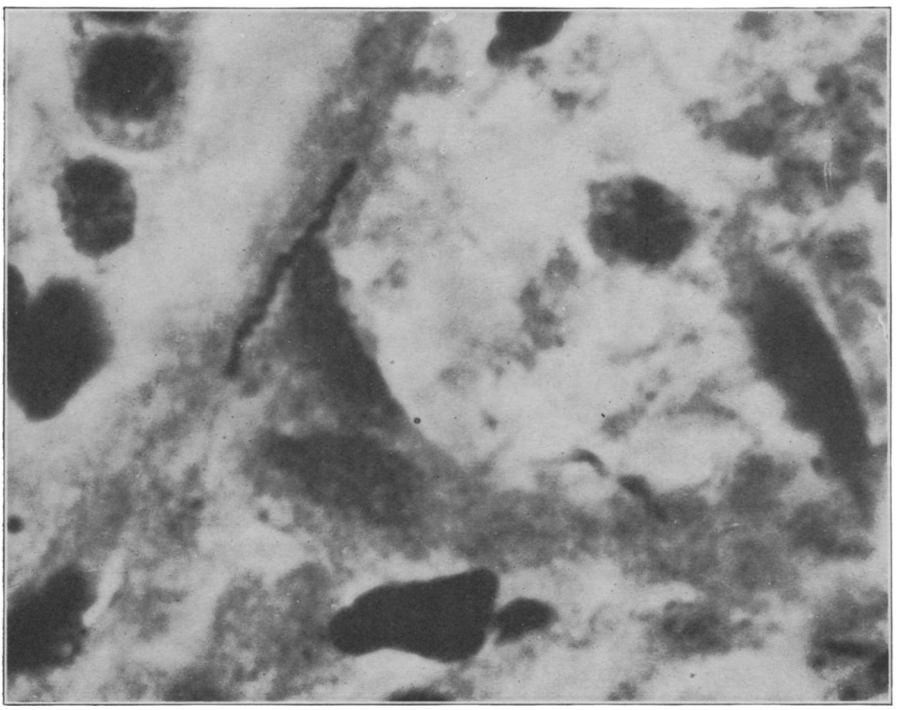

Fig. 11.—Wall of small intertubular capillary. Straightened-out Spirochaeta pallida in endothelial cell. Warthin-Starry method. Photomicrograph; same magnification as fig. 9.

congenital case dying soon after birth or to the child of 3½ years; but it had been given to the child dying at 8 days of age, and the death was supposed to have been due to the treatment, although the details are unknown to me. The child of 3½ years of age had albuminuria and symptoms suggesting poliomyelitis, the young woman of 23 years had casts and albuminuria; the urine of the young man had not been

examined. He was supposedly in good condition except for the chancre and roseolar eruption.

The tissues from these 5 cases were well fixed in 10% formalin, and had been preserved in formol for some time. Blocks from the kidneys were embedded in paraffin and the sections cut and mounted on cover glasses, and stained according to Warthin and Starry's silver-agar cover-glass method, with the additional use of hydrogen-peroxide as

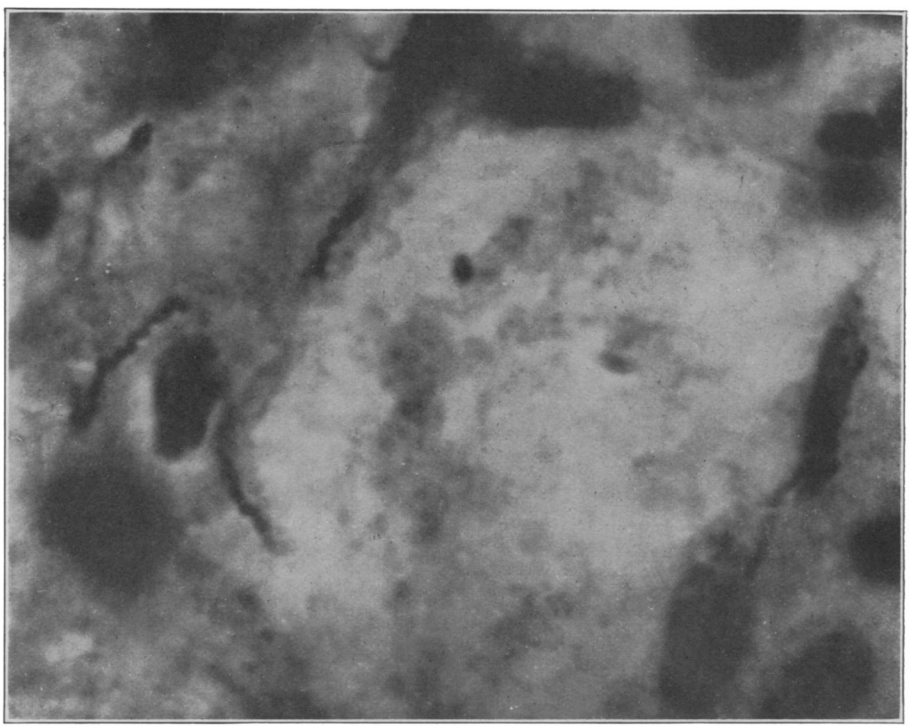

Fig. 12.—Small intertubular vessel. Two straightened-out spirochetes are seen on the left in the endothelium, several in the interstitial tissue to the left of the vessel; in the capillary wall on the right another straight organism in the endothelium out of focus. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 9.

an agent to clear out the tissue background and throw the individual spirochetes into greater relief. The Levaditi method and its variations have also been applied to the study of these tissues, but we have found our own method to be more constant, to show a greater number of spirochetes, and with greater contrast and detail of the organisms.

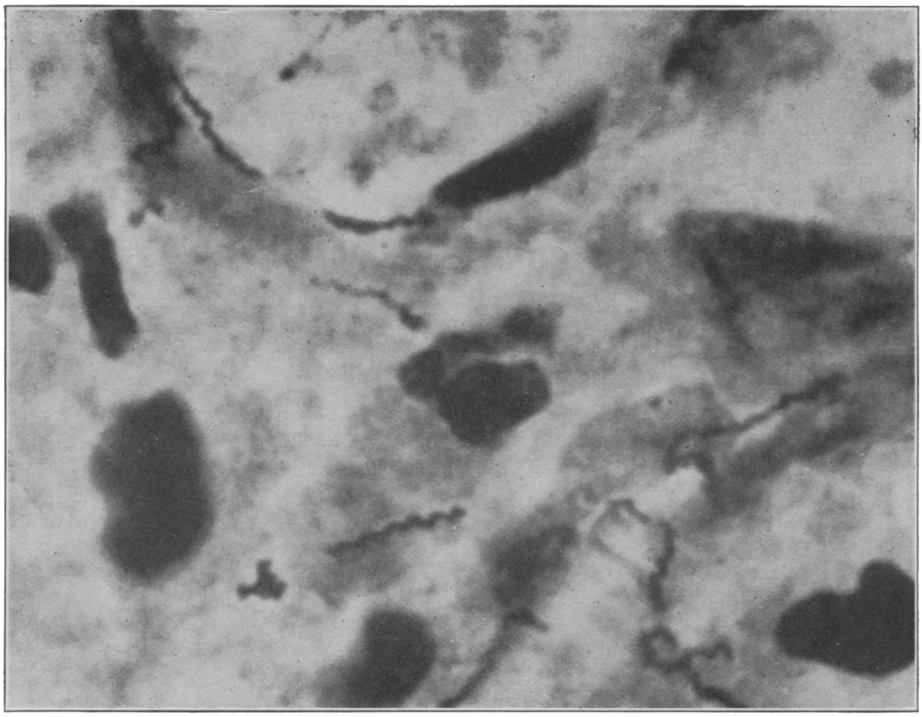

Fig. 13.—High-power view with intertubular capillary at top showing straightened spirochetes in the wall; below it numerous spirochetes massed in the intertubular interstitial tissue. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 9.

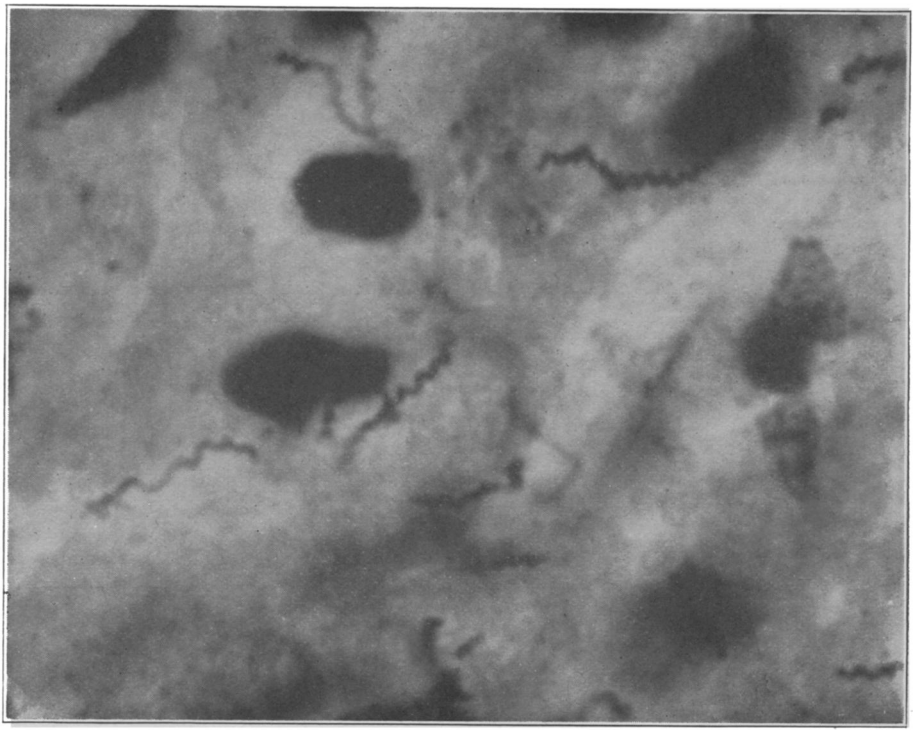

Fig. 14.—In the upper left hand a small tubule with spirochetes in the renal epithelium and spirochetal fragments in the lumen of the tubule. In the interstitial tissue numerous spirochetes in varying focus to show their massing between the tubules. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 9.

General Pathology of Kidney.—All 5 kidneys showed a general passive congestion and a parenchymatous degeneration most marked in the renal epithelium of the convoluted tubules, but involving the loops and straight tubules to some degree in the 2 adult cases. The intertubular interstitial tissue showed edema and an increase in the number of small cells, the majority of these being of the lymphocyte or plasma-cell

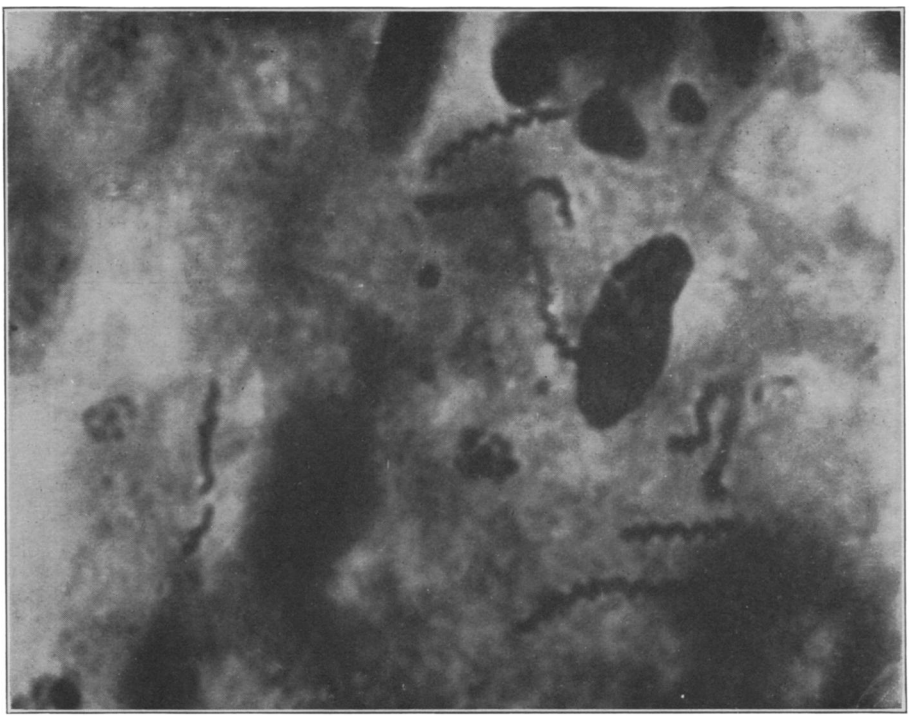

Fig. 15.—High power view of Spirochaeta pallida massed in intertubular interstitial tissue. Tubule at left with two degenerating spirochetes in renal epithelium. Warthin-Starry silver-agar method. Photomicrograph; objective B. & L., oil-immersion 2 mm., compensating ocular No. 4, bellows length 155 cm.

type. In one case only, that of the child of 3½ years with congenital syphilis were there any definite interstitial inflammatory areas. These were found between the tubules, particularly in the neighborhood of the larger blood vessels. They showed the same plasma-cell infiltrations with slight fibroblastic proliferation that characterize the localization of spirochetes elsewhere in the body. In these areas the silver stains showed the presence of great numbers of Spirochaeta pallida.

Glomeruli.—No degenerative or inflammatory lesions were found in the glomeruli. The capillaries were dilated. In these, occasional spirochetes were found, usually one to two in a glomerulus, never in greater numbers; and in many glomeruli no organisms were found. Occasionally they were seen in the subcapsular space or in the capsule itself. No degenerated forms of the organisms were found in the glomeruli.

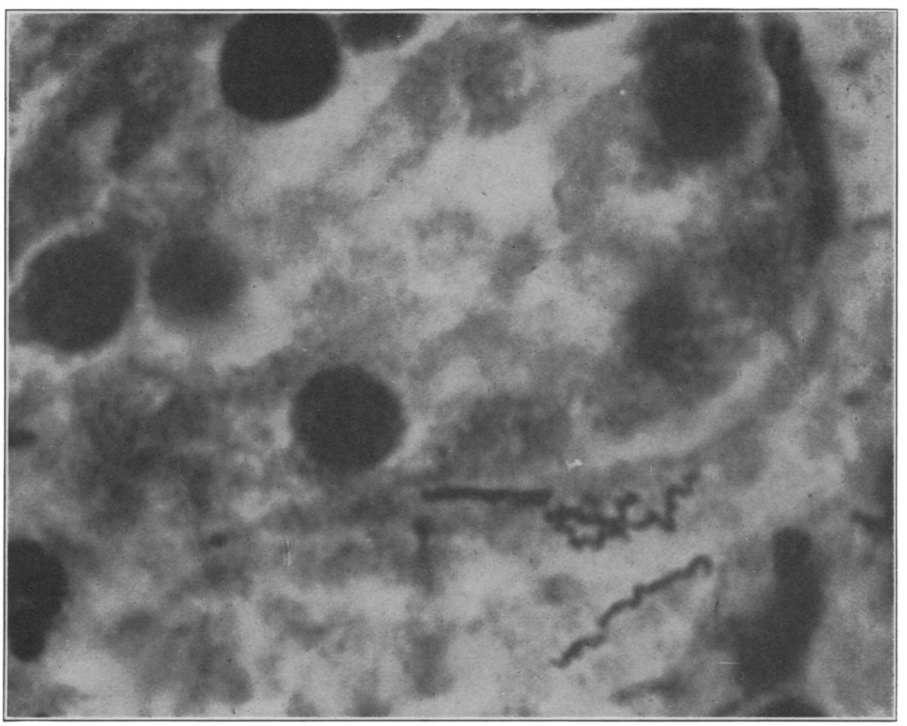

Fig. 16.—High power view of degenerating spirochetes in wall of tubule. Lumen of tubule contained many degenerating forms out of focus in this picture. Warthin-Starry silver-agar method. Photomicrograph, B. & L., 2 mm. oil-immersion, compensating ocular, No. 4, bellows length 85 cm.

Convoluted Tubules.—The spirochetes were massed in greatest numbers in the intertubular capillaries and lymph spaces of the edematous interstitial substance between and around the convoluted tubules. In the capillaries and small arteries they were present in great numbers in the lumen, but were often straightened out on the endothelium as if agglutinated to the endothelial cells. Some vessels seemed to be

lined with an internal layer of spirochetes. Passage of the organisms into and through the endothelium was seen in all stages. No degenerative changes were seen in the endothelial cells and no degenerative forms of the organisms were found in the vessel walls. In the interstitial tissue between the capillaries and the tubules the spirochetes were collected in great numbers, apparently free and unchanged. Around the basement membrane of the convoluted tubules they were heaped up, often entangled, sometimes attenuated, or straightened out, or coiled up into bizarre forms. They were often collected at certain portions of the

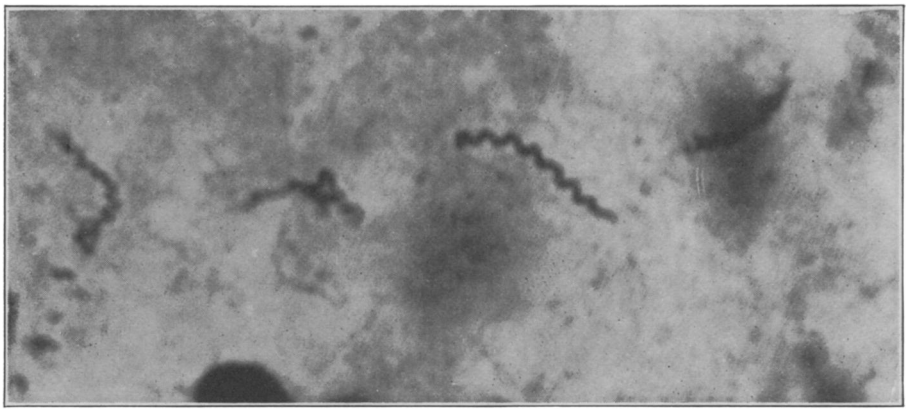

Fig. 17.—High power view of segment of convoluted tubule showing spirochetes in degenerated epithelium. Some of the organisms show degeneration. Spirochetes are toward the lumen, one nucleus showing below. Warthin-Starry silver-agar method. Photomicrograph, B. & L. oil-immersion 2 mm., compensating ocular, No. 4, bellows length 155 cm.

basement membrane as if drawn to that point. In other tubules the organisms formed a tight barricade entirely around the basement membrane of the tubule. Passage through the basement membrane into and between the renal epithelium was seen in all tubules. Phagocytosis of the organisms by the renal epithelum and by polymorphonuclear leukocytes was evident in the tubules. In the renal cells the spirochetes were well preserved until they approached the inner pole of the cells. Toward the lumen there was seen a marked fragmentation of the organisms, the spirochetes breaking up into fragments of all sizes, ultimately becoming granules which still become impregnated with silver. Other spirochetes reached the lumen apparently unchanged, and were found free in the lumen. As the spirochetes approach the lumen and begin to fragment they are often found arranged in a radiating position about the lumen.

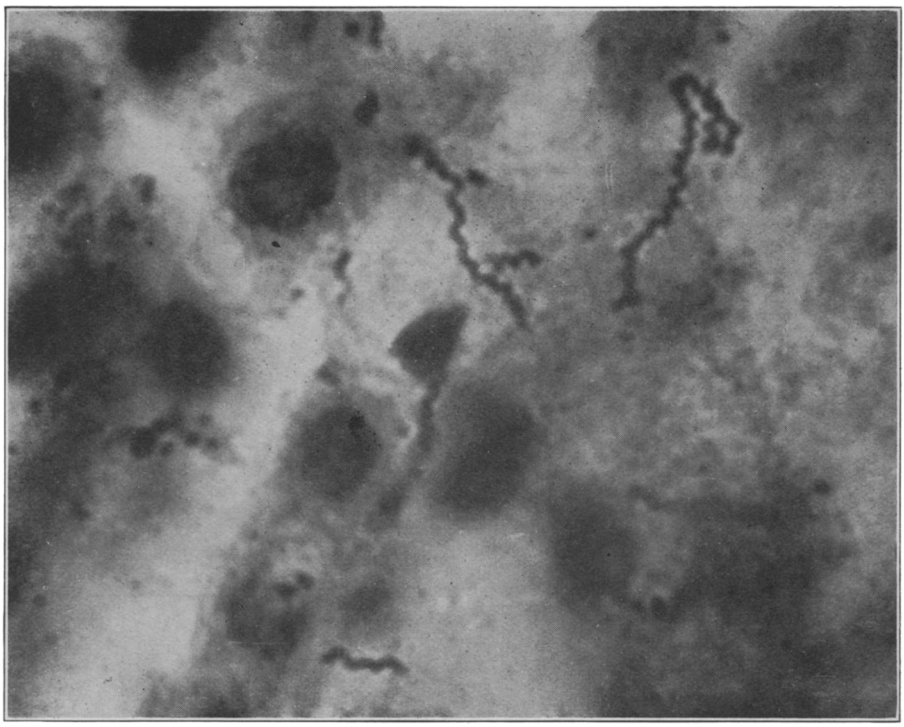

Fig. 18.—High power view of Spirochaeta pallida in walls of tubules; in the upper field the large organisms are in the renal epithelium. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 17.

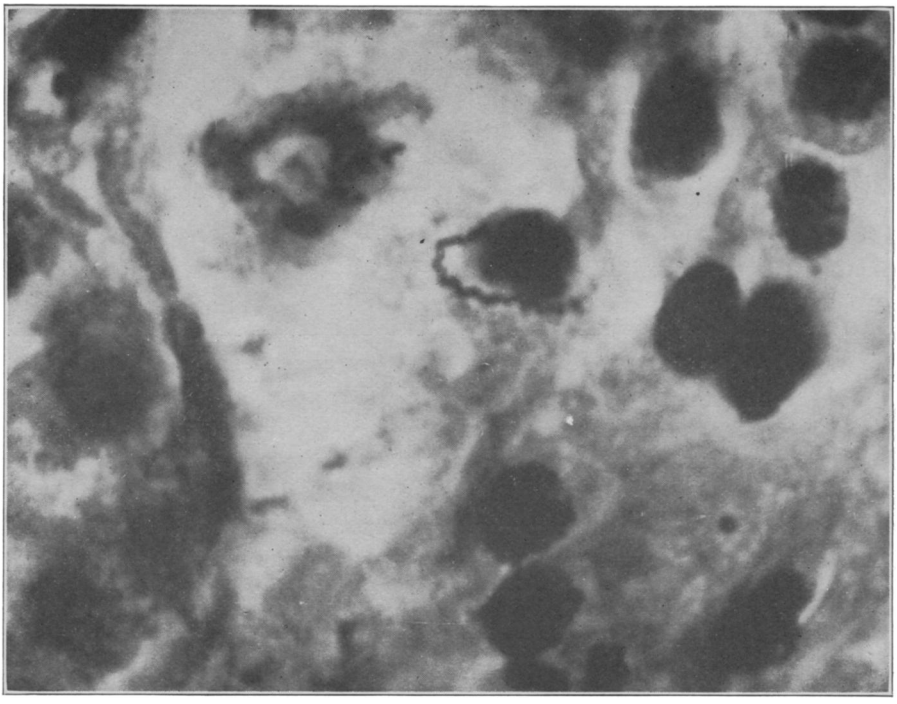

Fig. 19.—Phagocytosis of Spirochaeta pallida by renal epithelium; in the tubule a desquamated degenerating renal epithelial cell contains numerous fragments of degenerating spirochetes. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 17.

The tubular epithelium through which this process of elimination is taking place shows varying degrees of cloudy swelling, hyaline change or complete cytolysis. Fat droplets are not present in the degenerating cells. The lumina of the tubules are narrowed, often completely blocked by the swollen cells, or are filled with a granular detritus from exudate or broken-down cells. In such granular casts spirochetes, either unchanged, or presenting various stages of disintegration are

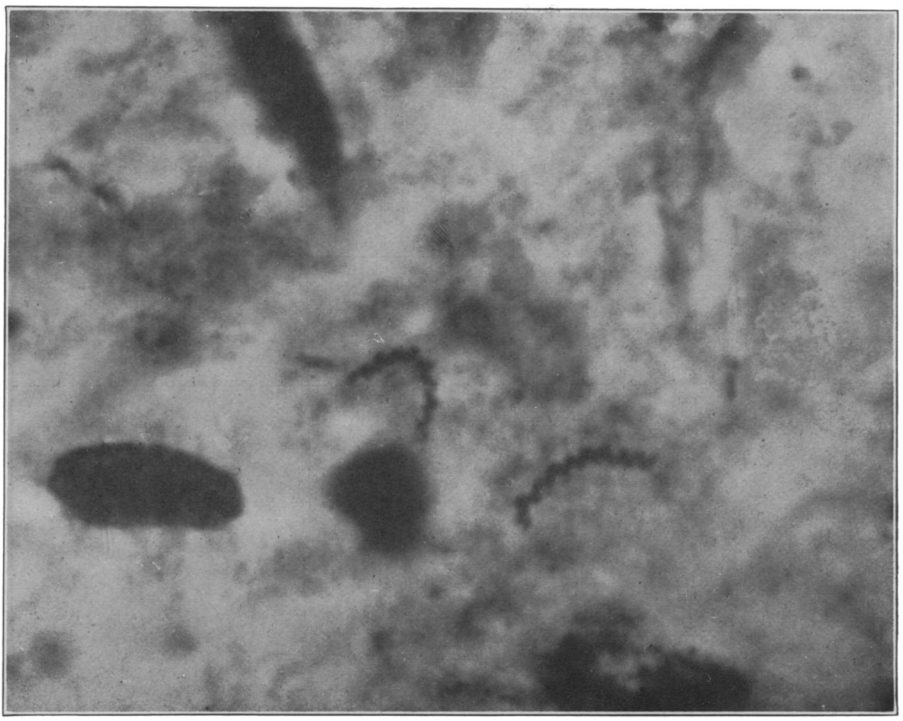

Fig. 20.—Tubule with lumen blocked by detritus and swollen epithelium; in the latter two spirochetes showing beginning coiling. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 17.

present in great numbers. Desquamated cells containing single or numerous organisms are common in the lumina. In the phagocytes the spirochetes often become coiled into a loop or circle, which gradually contracts and condenses until it forms a round granule still taking the silver impregnation. All stages of this phagocytosis and destruction of the organism are shown. The great majority of the organisms reaching

the lumina show signs of disintegration. In the loops of Henle the passage of the organisms through the walls of the tubules occurs at a greatly reduced rate, although the intertubular tissue is often closely packed with them. In the straight tubules the organisms within the lumen of the tubules diminish in number until in the medullary pyramids they almost entirely disappear from the tubules, only occasional ones being found free within the tubule or in casts. Granular

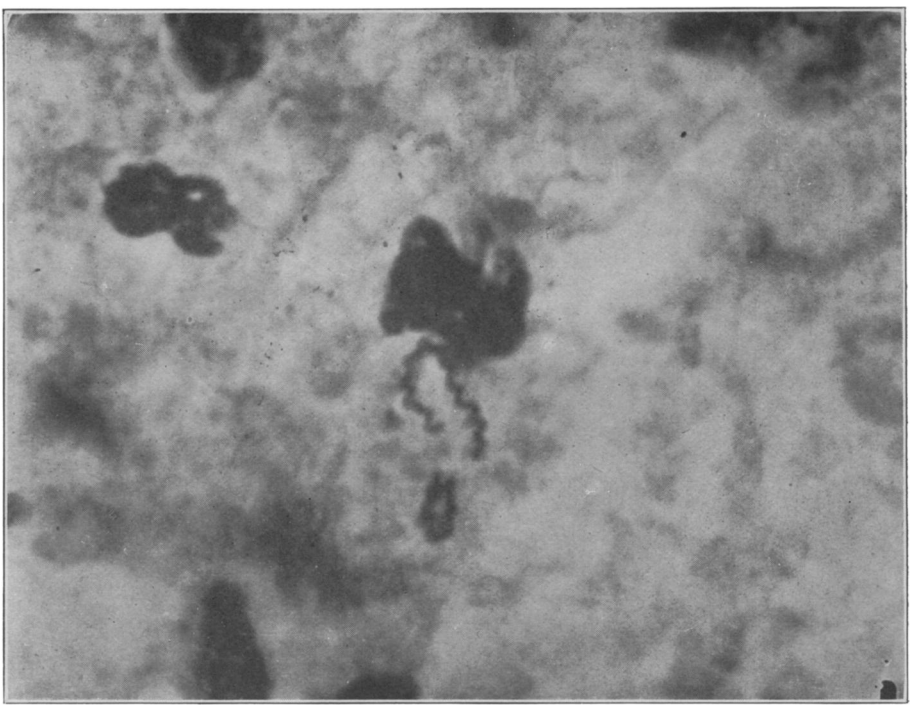

Fig. 21.—Lumen of tubule with swollen epithelial cell showing two enclosed spirochetes in different stages of coil formation, the lower one contracting and condensing, the final stage of phagocytosis. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 17.

and beaded spirochetes were numerous in the lumina. The fragments of the disintegrated organisms apparently lose their affinity for silver impregnation in the straight tubules as these become fewer and fewer in the collecting tubules. The intertubular vessels in the medullary pyramids, however, contain great numbers of spirochetes, as does also the intertubular interstitial tissue, decreasing however toward the papilla.

From the appearances presented by the sections of these kidneys the excretion of Spirochaeta pallida takes place chiefly through the convoluted tubules. The majority of the organisms appear to pass directly through the renal epithelium. These cells show a marked degeneration, cloudy swelling or a hyaline parenchymatous degeneration, both leading ultimately to complete cytolysis. The cytoplasm shows more change than the nuclei, although with cytolysis the latter lose their staining

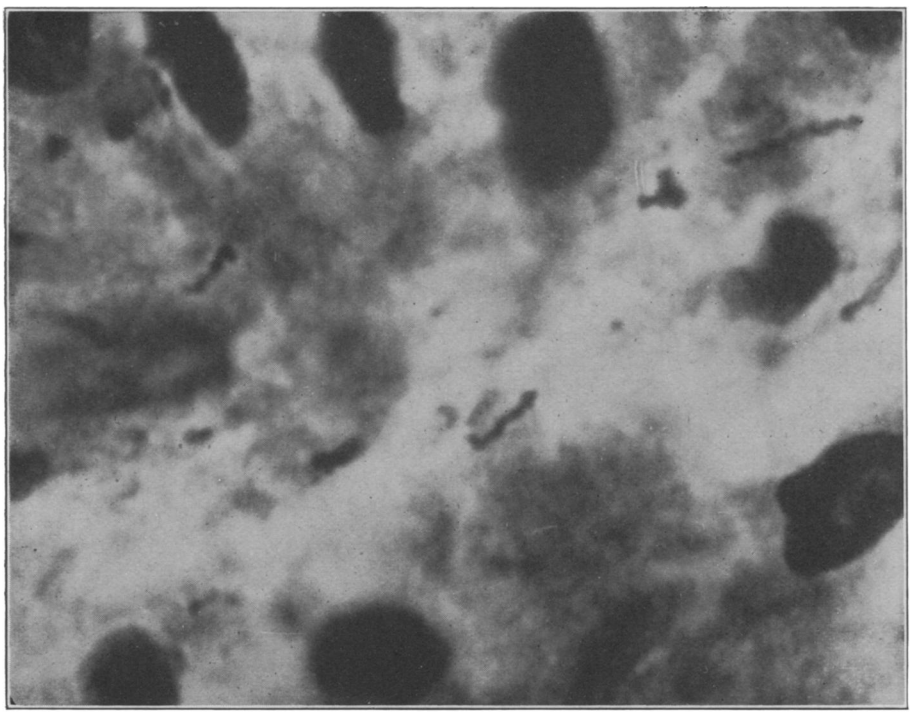

Fig. 22.—Fragments of spirochetes in the detritus in lumen of tubule. In the epithelium at top spirochetes radiating toward the lumen can be seen. Warthin-Starry method. Photomicrograph; same magnification as fig. 17.

power. A definite relation seems to exist between the degree of degeneration of the cells and the disintegration of the spirochetes. The destruction of the organisms appears to take place chiefly toward the lumen and in the latter. In the urine the great majority of them must disappear completely; and only a small number of them, presumably the viable ones, may reach the bladder and appear in the excreted urine.

The search in the urine for such evidence of syphilitic infection cannot, therefore, be expected to be of any great value as a diagnostic method. If in all cases the destruction of the excreted spirochetes is as great as it is in these kidneys, the demonstration of spirocheturia in syphilis must be a rare and largely accidental observation.

The excretion through the kidneys of Spirochaeta pallida takes place under the same conditions and apparently with the same mechanism as

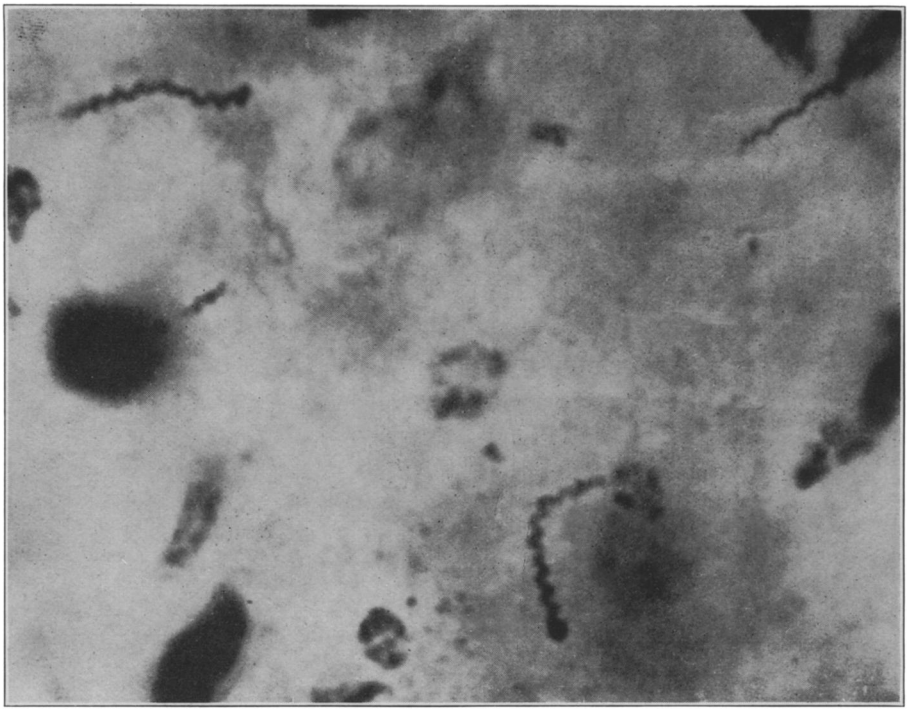

Fig. 23.—Tubule showing radial arrangement of spirochetes toward the lumen; in the latter numerous degenerating fragments of spirochetes were present, only a few in focus. Warthin-Starry silver-agar method. Photomicrograph; same magnification as fig. 17.

described for the spirocheturia of infectious jaundice. There is a more or less generalized spirochetosis in the body, with spirochetemia. In the kidney there occurs a massing of the spirochetes about the convoluted tubules and a passage of the organisms from the vessels and interstitial tissues into the tubules where they undergo disintegration for the greater part. This destruction of the organisms in the kidneys is more marked

in the case of syphilis than in infectious jaundice. The spirocheturia of the latter disease is a more marked and constant feature of the infection than it would appear to be in syphilis. This point can be settled only by future examinations of urine on a more extensive scale during the stage of spirochetemia following the development of the chancre and the early cutaneous manifestations. It does not seem likely, however, that spirocheturia in acquired syphilis will become a diagnostic factor of importance as it is in Weil's disease. In the case of septicemic congenital syphilis such spirocheturia is more likely to be found.

In the icterigenic spirocheturia and that of syphilis definite renal lesions are present. In Weil's disease the renal injury is much greater than in these five cases of syphilis, and in proportion to this greater degeneration of the epithelium of the convoluted tubules there is a much greater excretion of Spirochaeta icterohaemorrhagica. The occurrence of spirocheturia in syphilis has, nevertheless, an important bearing on the much discussed question of a precocious syphilitic nephritis. From these cases it would appear that such a syphilitic injury of the kidneys does occur during the septicemic stage of the infection. In suspected cases of early syphilitic nephritis the examination of the urine for the presence of renal spirochetes, by using proper precautions to prevent urethral contamination, might become an important diagnostic procedure in determining the nature of the renal lesion.

The fact that three of these patients had been given arsphenamin treatment may be of importance in determining the degree of primary or secondary injury to the kidneys, as well as the degree of spirocheturia. As spirocheturia does not take place to any marked degree in Weil's disease until after the tenth day when immune bodies are forming, it is possible that the same is true of syphilitic spirocheturia. Further, any spirocheticidal treatment may in itself be a factor in rendering the spirochetes of syphilis more susceptible to passage through the renal epithelium, or the injury to the latter resulting from the therapeutic measures may make the kidneys more pervious to their passage.

CONCLUSION

Spirocheturia appears to be a striking phenomenon of the entire group of spirochetal infections. The elimination of the spirochetes through the kidneys with the production of associated renal lesions appears to constitute a family characteristic in so far as the known types of the organisms have been studied thoroughly. It is best known

in the case of infectious jaundice, and in this disease is a factor of considerable diagnostic value.

Syphilitic spirocheturia occurs in the stage of septicemic syphilis, in both the congenital and acquired infections. Spirochaeta pallida, as is Spirochaeta icterohaemorrhagica, may be excreted in enormous numbers through the convoluted tubules. During such excretion through the kidneys the spirochete of syphilis suffers greater destruction than does the icterogenic parasite, so that fewer spirochetes may reach the urine in syphilis than in infectious jaundice. The demonstration of the occurrence of syphilitic spirocheturia, is, therefore, not likely to possess such diagnostic value as that of icterogenic spirocheturia.

It seems probable that spirocheturia is more likely to occur when the spirochetes in the blood stream are exposed to the action of antibodies or spirocheticidal drugs. Further, spirocheturia in any degree, both in the case of syphilis and infectious jaundice, appears to be associated with definite degenerative lesions of the epithelium of the convoluted tubules. Such lesions may make the tubules more pervious to the passage of the spirochetes.